Aura Validation : H_2O and N_2O Subgroup Session

TES
Bob Herman

MLS
Alyn Lambert (N_2O and stratospheric/mesopheric H_2O
Bill Read (tropospheric H_2O and RH)

HIRDLS
John Gille

***In situ*/*In situ* and *In situ*/MLS comparisons**
Elliot Weinstock
Holger Vömel

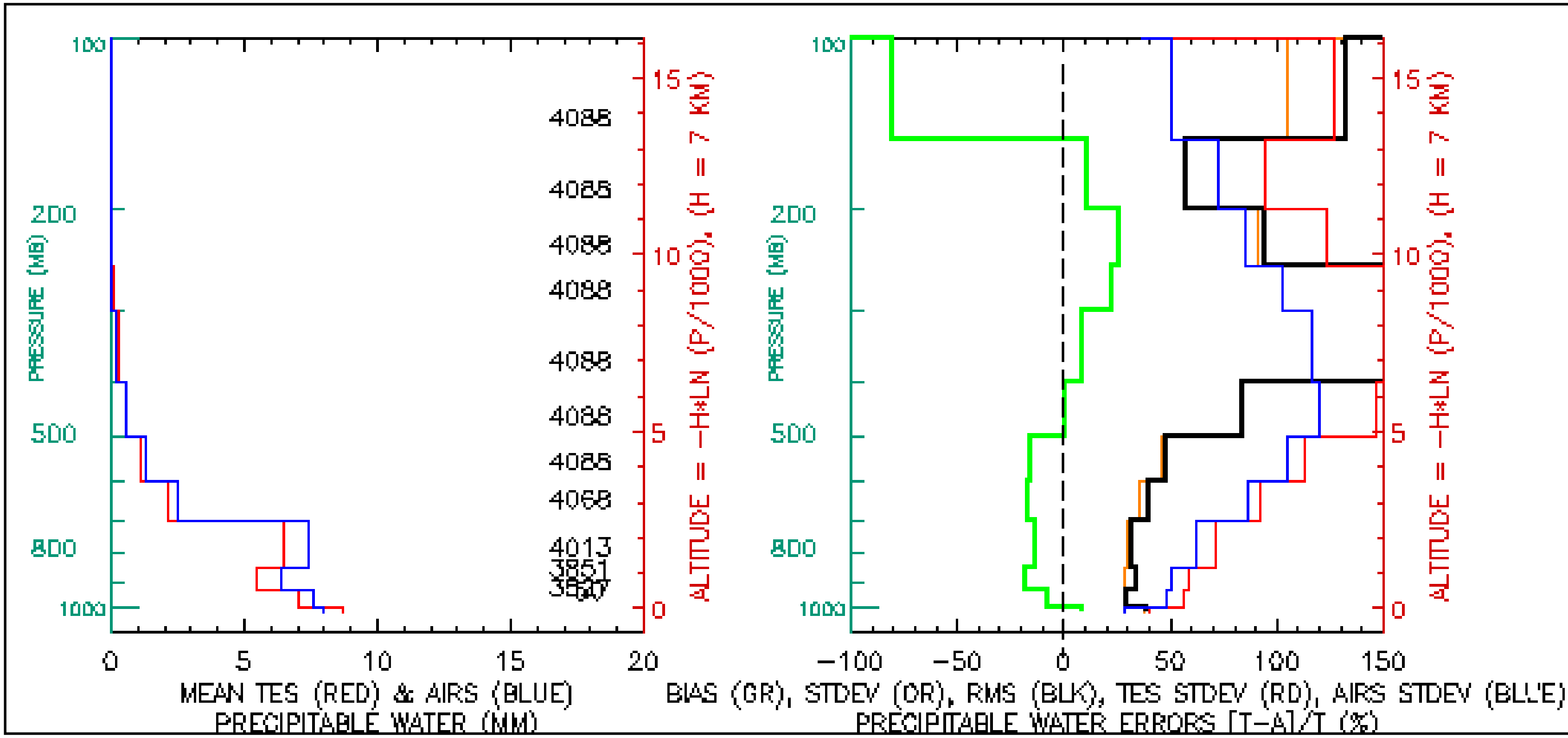
General Discussion

TES v002 water comparisons (this is the version currently on the DAAC)

TES 15-20% drier than AIRS at 500-1000 hPa.

TES 10-25% wetter than AIRS at 150-500 hPa.

Bob Herman



Mean profiles

TES - AIRS

% Bias in green ([TES-AIRS]/TES), rms differences in black

Note: Little latitudinal dependence on TES/AIRS differences.

TES compared with sondes, averaging kernal applied to sonde data prior to comparisons.

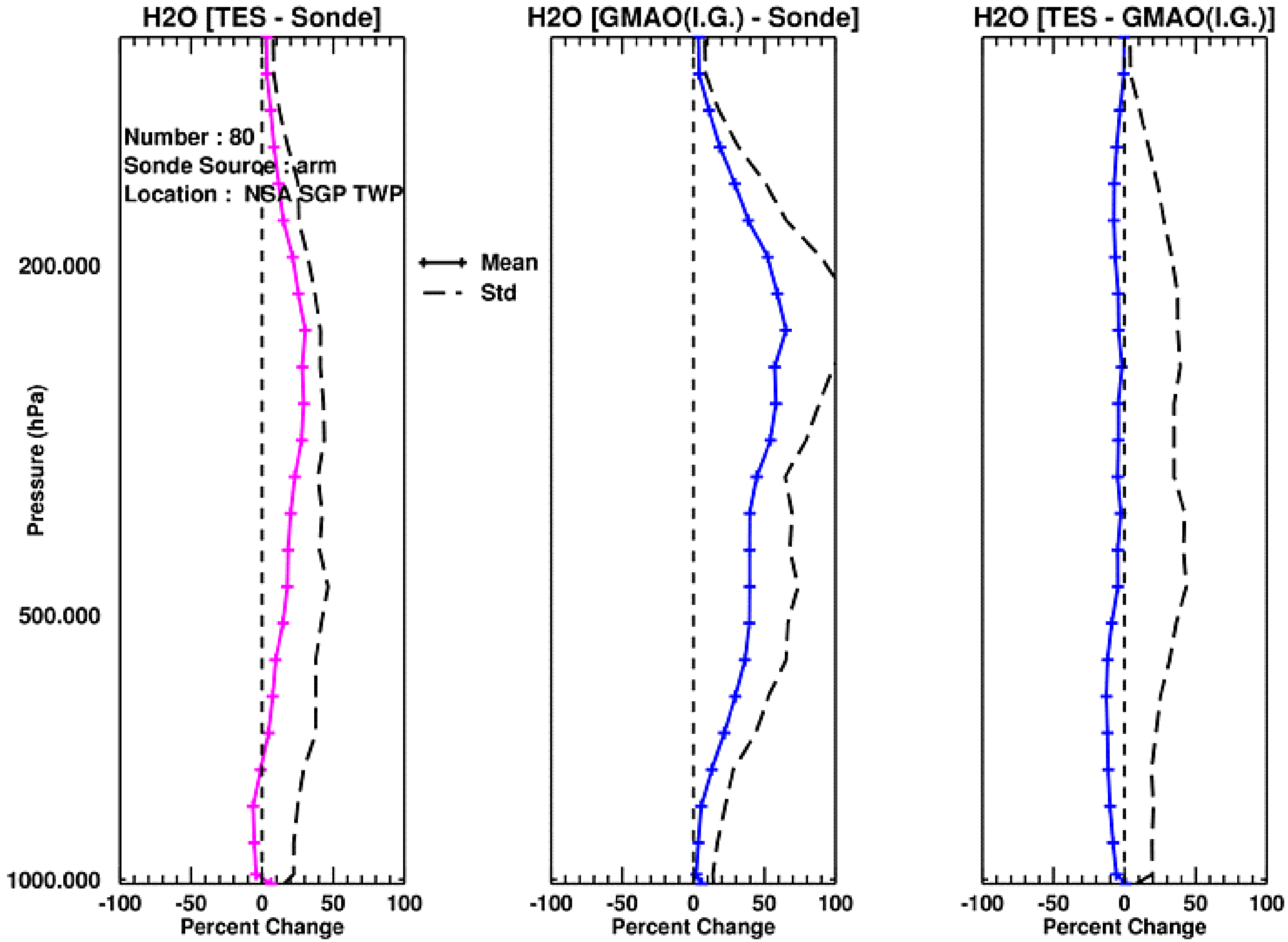
Bob Herman

80 radiosondes (RS90 and RS92) compared with TES special obs. at DOE ARM sites.

Coincidence criteria:

within 2 hours and 250 km of the sonde launch.

TES 0-30% wetter than sondes at 100-700 hPa.



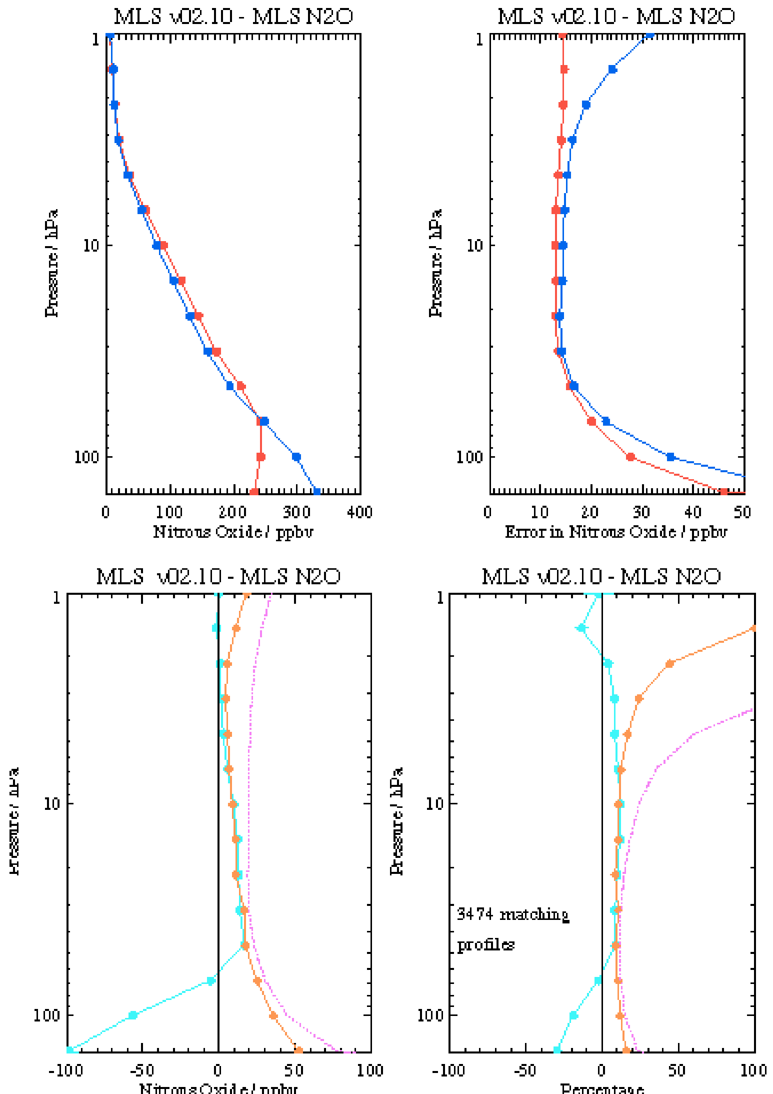
Sonde comparisons demonstrate that TES improves on GMAO H_2O

TES SUMMARY

- TES v002 is 10-25% wetter than AIRS at 150-500 hPa.
- TES v002 is 15-20% drier than AIRS at 500-1000 hPa.
- TES v002 is 0-30% wetter than ARM site radiosondes at 100-700 hPa.
- The next release of TES data (v003) is coming.
- Next step: a more thorough analysis of CFH, NCEP sondes and aircraft data (including INTEX).
- Future validation needs: TES limb water vapor and high-latitude measurements poleward of 50 degrees.

Bob Herman

Comparison of MLS v2.10 N_2O with v1.51

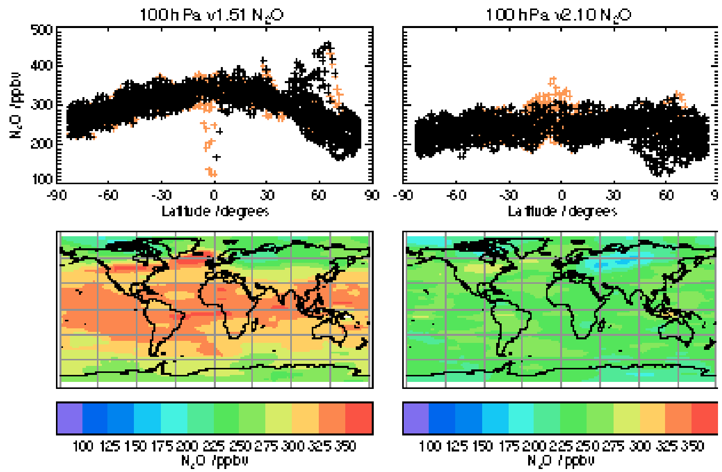


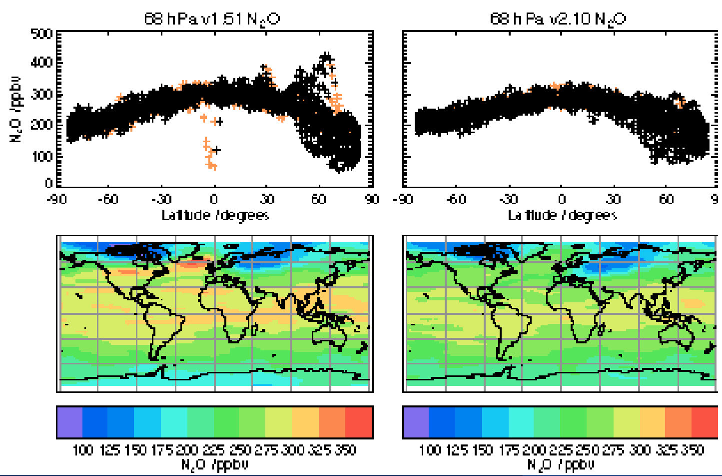
28 January 2005

- Upper panel: Global mean vertical profiles
  - MLS versions v2.10 and v1.51
  - Left: Mean vmr profile
  - Right: RMS precision profile
- Lower panel: Global mean difference vertical profiles
  - Left: Statistics of profile differences in vmr units
    - Mean difference (v2.10 – v1.51)
    - RMS difference
    - Expected RMS difference
  - Right: as Left except shown as a percentage

Alyn Lambert, N_2O

Anomalies in the N_2O Data Product





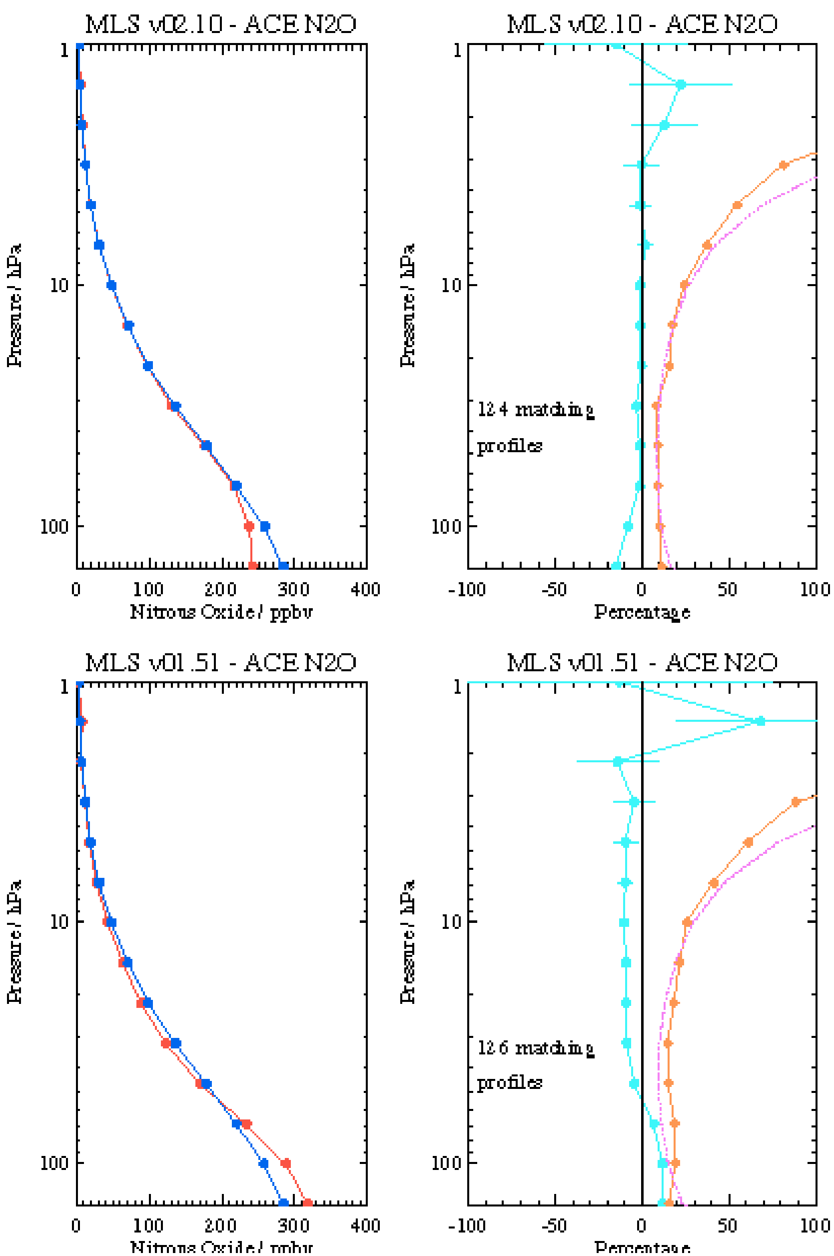
- Upper panel: 100 hPa N_2O
  - Left: v1.51
    - Scatter plot: orange points indicate data marked by status/quality flags
    - Map: latitude – longitude distribution
  - Right: as Left except for v2.10
- Lower panel: as Upper panel except for 68 hPa N_2O

Not all anomalous data points were detected by the status/quality flags in v1.51 (an off-line data mask is available)

v2.10 N_2O is clearly too low at 100 hPa, but at 68 hPa the artifacts due to poor convergence in v1.51 have been improved

Alyn Lambert, N_2O

Example: ACE/MLS comparison



N_2O Summary

MLS v2.10 N20 is ~10% larger than v1.51 in the mid-stratosphere

In general, the biases and rms scatter of MLS v2.10 N_2O against ACE, MIPAS and SMR are very good and show significant improvements over the MLS v1.51 data

Problems with poor convergence have been reduced in the MLS v2.10 retrievals

Further refinements will address the problem with low values of N_2O at 100 hPa and greater pressures

Alyn Lambert, N_2O

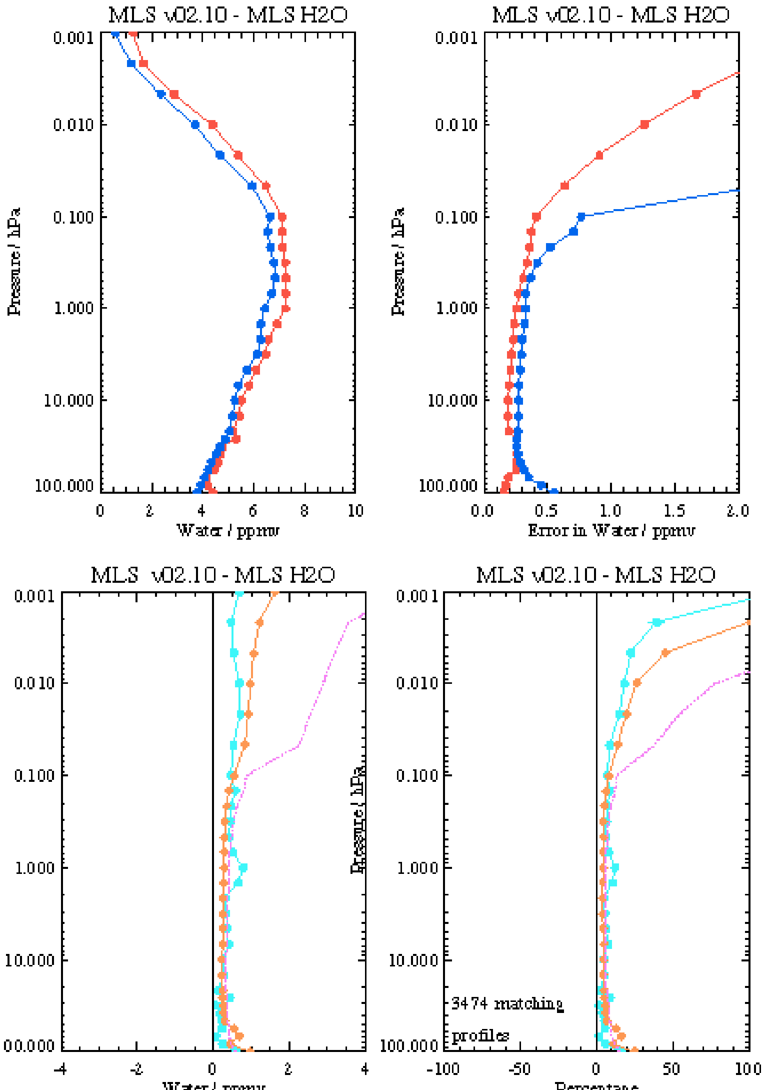
Improvements to the retrieval scheme for v2.10

- Updated spectroscopy for H_2O and contaminating species (O_3, HNO_3)
- Increased vertical resolution in the UTLS (12 levels per decade for pressures $\geq$ 22 hPa)
- Reduced error inflation (artificial increase of radiance noise to allow for uncertainties in the forward model)
- Included fine spectral resolution DACS radiances to improve mesospheric H_2O retrievals

Stratospheric water, MLS

Alyn Lambert, H_2O

Comparison of MLS v2.10 H_2O with v1.51



28 January 2005

v2.10 H_2O is $\sim$0.5 ppmv larger than v1.51

- Upper panel: Global mean vertical profiles
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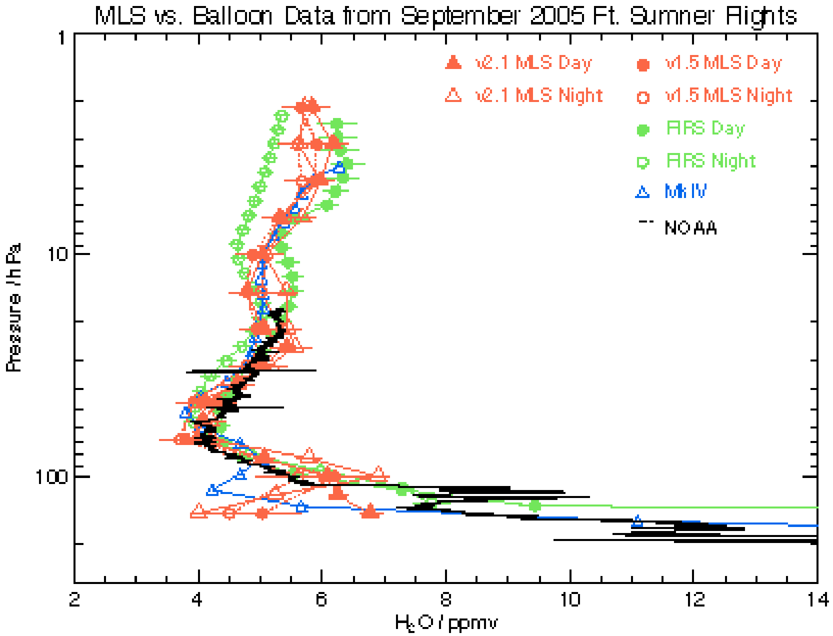
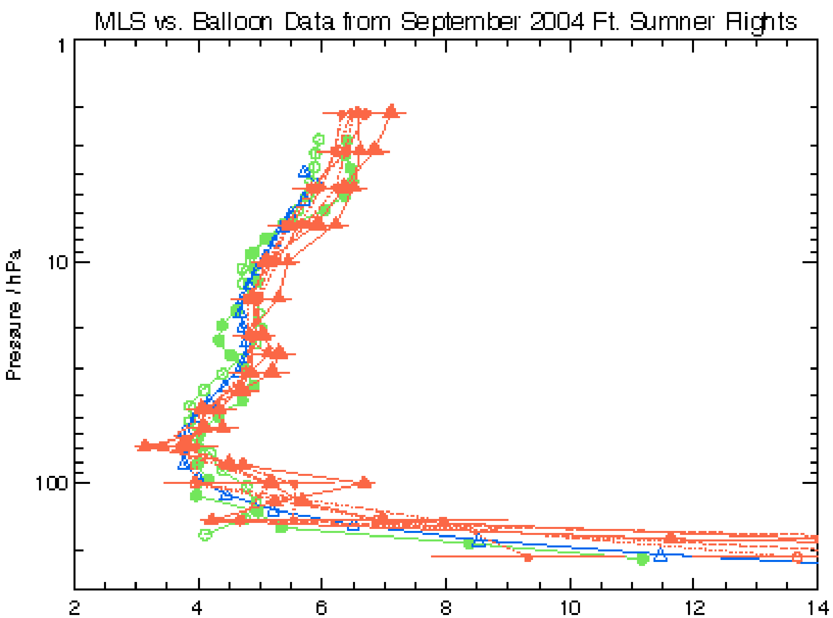
Alyn Lambert, H_2O





Ft Sumner Balloon comparisons (Sept 2005 and Sept 2004)

MLS Strat H_2O summary

MLS v2.10 stratospheric H_2O is 0.5 ppmv higher at all altitudes than v1.51

The estimated precision of MLS v2.10 H2O is < 0.5 ppmv for pressures > 0.1 hPa

A stratospheric wet bias is seen in the comparisons with ACE, however,there is better agreement with MIPAS in the low stratosphere and at the stratopause then for v1.51 data

Vertical oscillations can be seen in the low stratosphere in single profile comparisons

Further refinements of the MLS Level-2 H_2O data product will address these issues

Alyn Lambert, H_2O

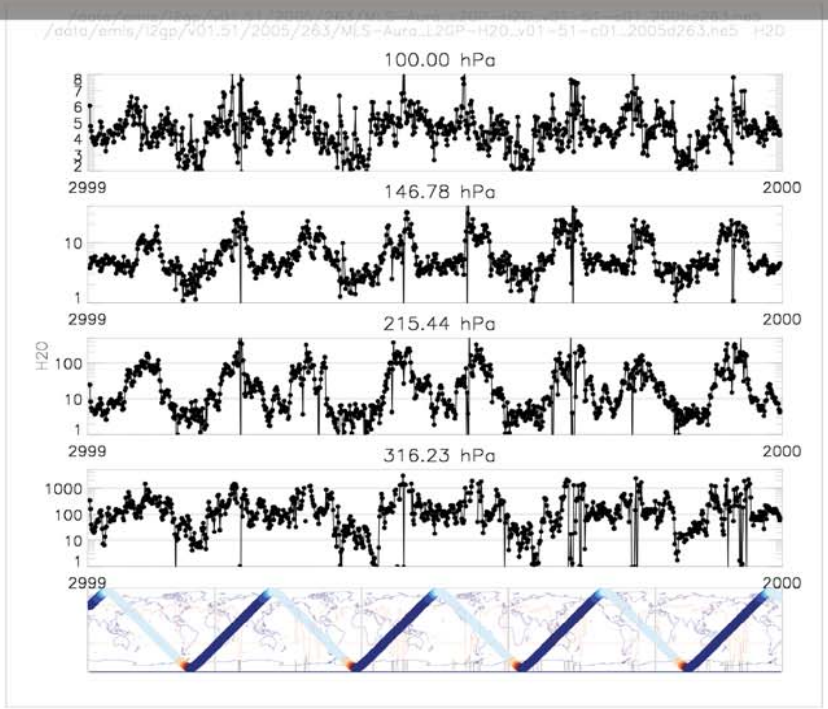
V2.1 MLS H_2O & RHi Measurements

- Coverage is 82°S – 82°N 240 profiles per orbit, ~14.5 orbits per day (~3500 profiles daily).
- Vertical coverage is 681(sometimes)–0.001 hPa.
  - Relative humidity is retrieved at 681 and 464 hPa using a saturated radiance slant path technique (similar to nadir sensors).
    - Resolution is 100 km (along track) X 6 km (cross track) X 4 km (vertical).
    - Not sensitive to temperature errors---good for supersaturation detection but derived specific humidity accuracy strongly depends on T accuracy.
    - Single profile precision is 40% at 681 hPa and 17% at 464 hPa.
  - Specific Humidity (or H_2O) is retrieved from 316—0.001 hPa using the spectral radiance limb viewing technique.
    - Retrieved every 1.3 km from 316—22 hPa and more coarse above 22 hPa.
    - Resolution is 160 km (along track) X 6 km (cross track) X TBD (~2.5—3 km troposphere).
    - Not sensitive to T accuracy but derived RH will be.
    - Single profile precision is ~5% between 316—83 hPa.
  - Will focus on the 681, 464, 316, 261, 215, 147, 121, 100 and 83 hPa levels here and will only show specific humidity.

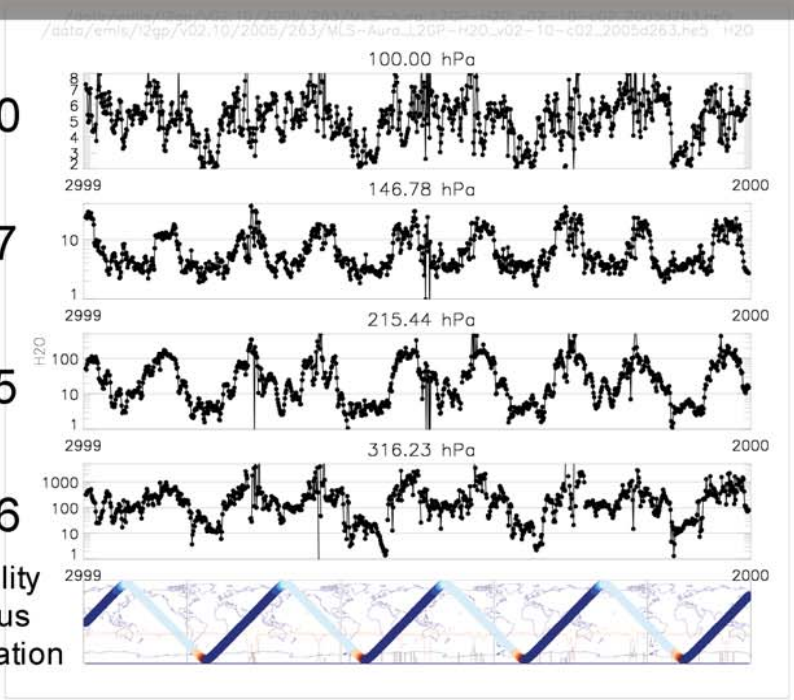
18 days of V2.1 H_2O currently available

Bill Read

MLS v1.51 | MLS v2.1



100
147
215
316
Quality Status Location

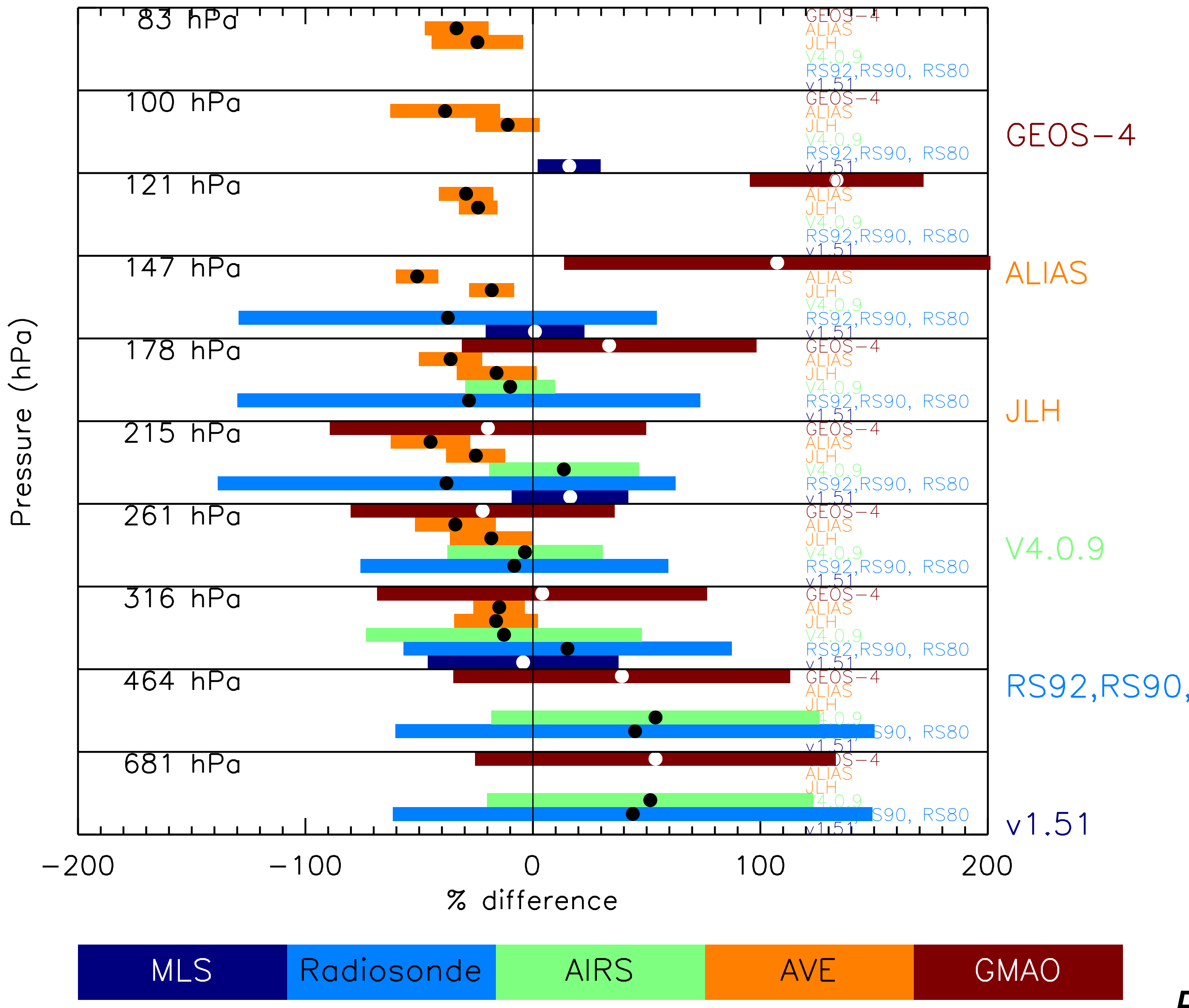


- MLS v1.5 had problems with dry spikes at 316 hPa.
- Poor convergence in clouds.
- 10—25% precision in troposphere.

- Time series look similar.
- Note less noisy appearance of 215 and 316 levels. Fewer dry spikes.
- 100 hPa is more ragged.
- Poor convergence in clouds.

Bill Read

Summary



Bill Read

Conclusions

- Mean differences with Vaisala (RS80/90/92) radiosondes between 316—261 hPa and with AIRS between 316—177hPa are < 20%.
  - The scatter about the mean is large, typically about 60-70% for the radiosondes and AIRS at 316 hPa.
  - With AIRS, the scatter is drops to ~30-35% between 261—177 hPa.
  - Important not to compare AIRS humidity measurements when H2O < 50 ppmv.
- MLS is consistently 10—25% drier than JLH at all altitudes. ALIAS is very close to JLH except when it encounters cirrus. On the 22 Jan 2006 flight, a cirrus event was detected (large difference between JLH and ALIAS) which did not appear to impact the MLS H_2O measurement.
  - Although the spatial and temporal coverage of the in-situ is much more limited, the scatter is smaller than the best achieved with other satellite—even down to 316 hPa.
  - Perhaps benefiting from comparing like measurements (specific humidity).
- At this time the MLS relative humidity measurements at 681 and 464 hPa do not appear to be of high quality.
  - They are biased high.
  - Large scatter about the mean.
- GEOS-4 shows larger scatter with MLS than with other measurements.
  - GEOS could benefit from assimilating the MLS humidity.

Looking toward v2.2

- Improve the 681—464hPa RH retrieval.
- Improve convergence: currently ~60%.
- Less noisy at 100 & 83 hPa.

Bill Read

HIRDLS

Caveats:

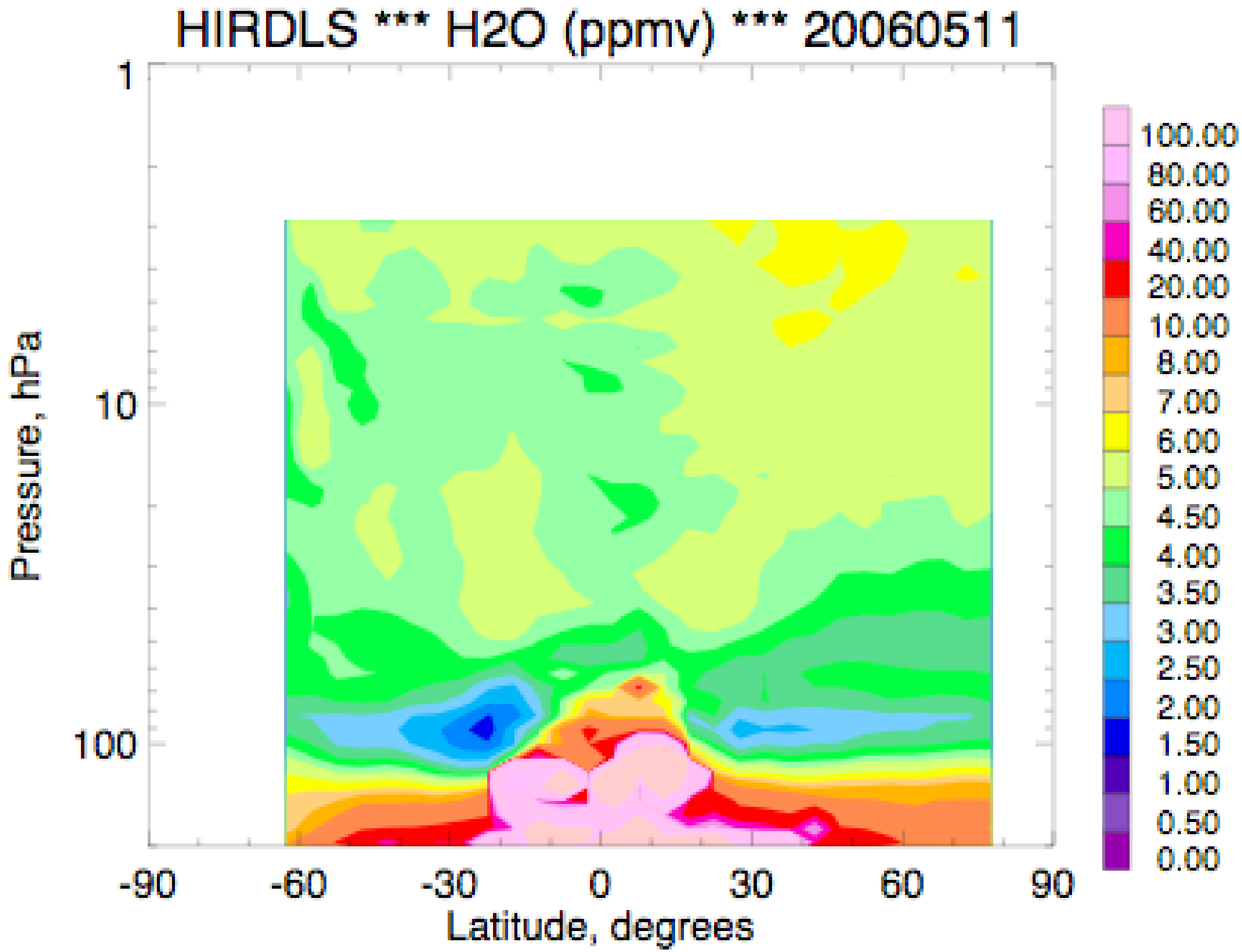
Water vapor results very sensitive to oscillation perturbations

Most effective versions of the “Deoscillation” algorithms are very new

Useful water vapor results are also quite new, so not much time to study in detail. These are first looks.

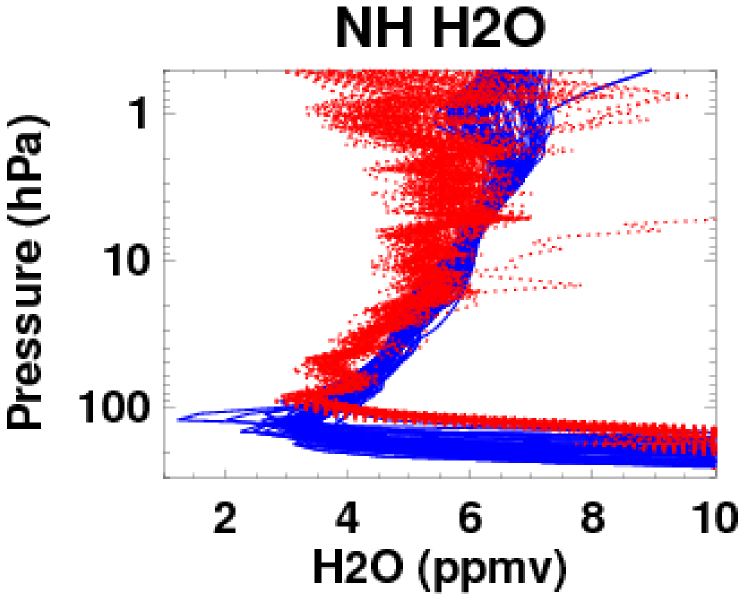
John Gille

Zonal Mean Water Vapor

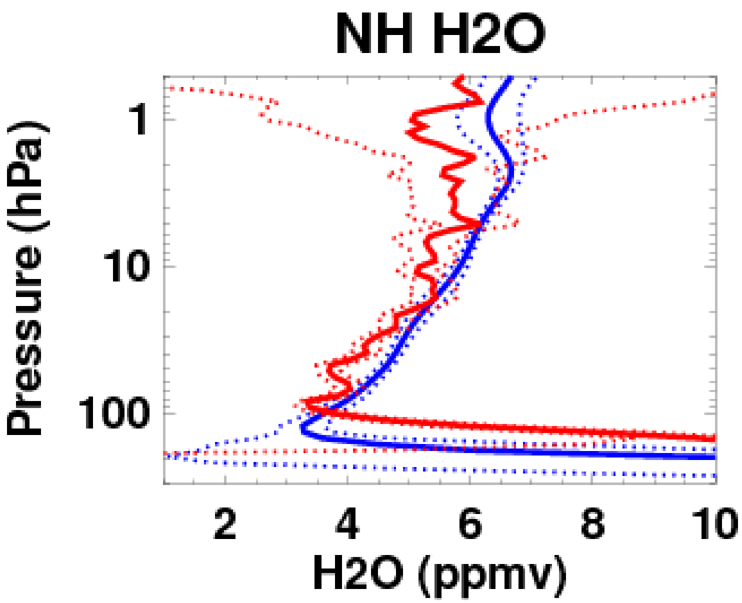


John Gille

HIRDLS & ACE Water Vapor Profiles



All Coincidences
Within 2 hours

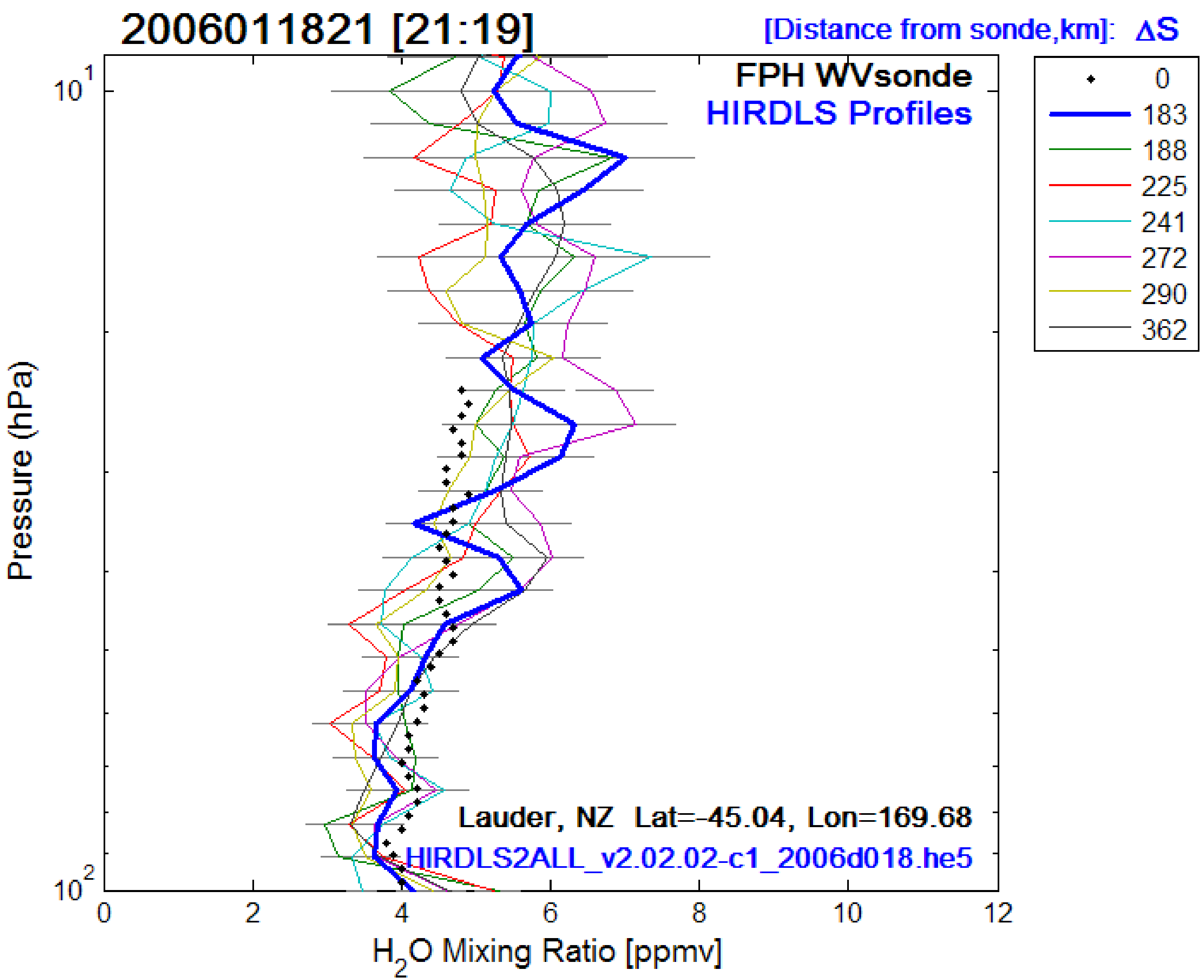


Average (solid) & 1-σ standard deviation (dotted)

Cora Randall, Peter Bernath and the ACE Team

John Gille

Sonde Comparison- Lauder NZ



John Gille

Summary

Water vapor cross-section and zonal means have reasonable values

Some evidence of residual oscillation for some scan tables (refine)

Values too high in tropics above the tropopause (blockage correction)

Problems-

- **Small scale horizontal variability**
- **Small scale vertical variability**
- **Possible problems at high latitude, high altitude**

Data are clearly on the right track, much further refinement is needed.

John Gille

Intercomparisons of the Harvard Lyman alpha hygrometer and ICOS isotopic water instrument with the CFH and MLS instruments: Implications of recent results

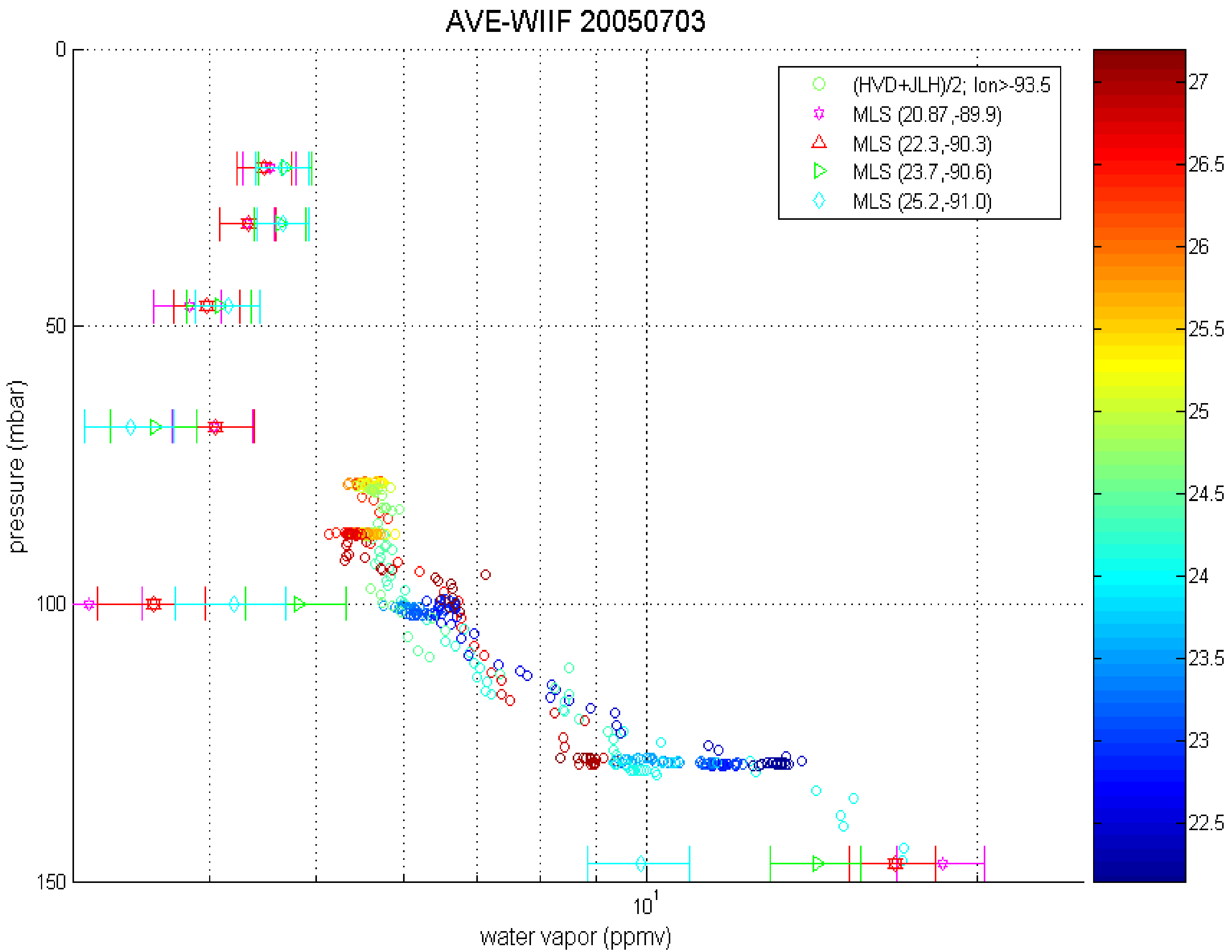
Questions to be explored

Are intercomparison data from CRAVE and AVE-WIIF consistent?

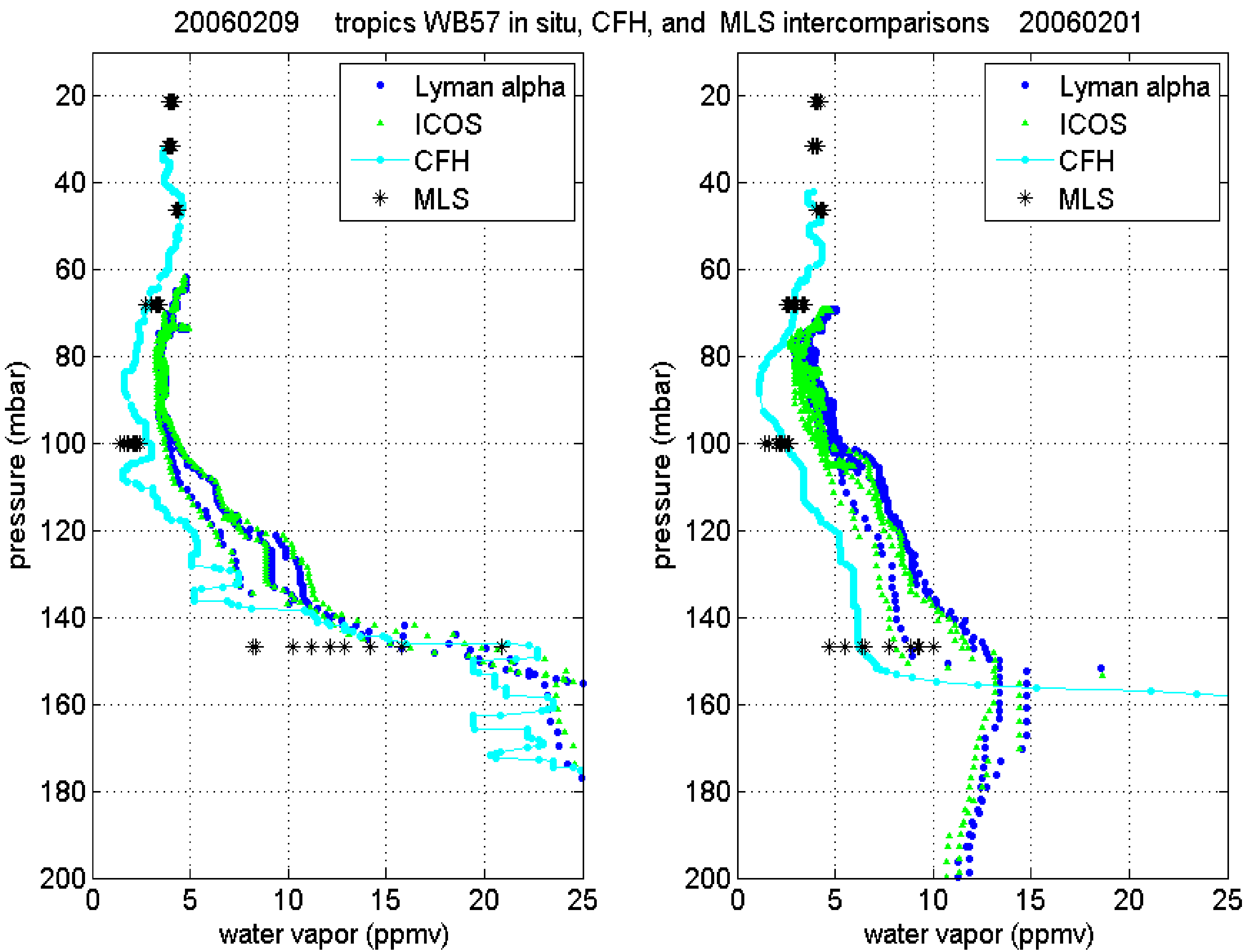
What have we learned from CRAVE regarding the accuracy of in situ water instruments needed for Aura satellite validation, especially regarding the previously observed systematic differences between the frost point hygrometer and in situ aircraft instruments?

How do MLS version 1.5 and version 2 compare with in situ water vapor measurements?

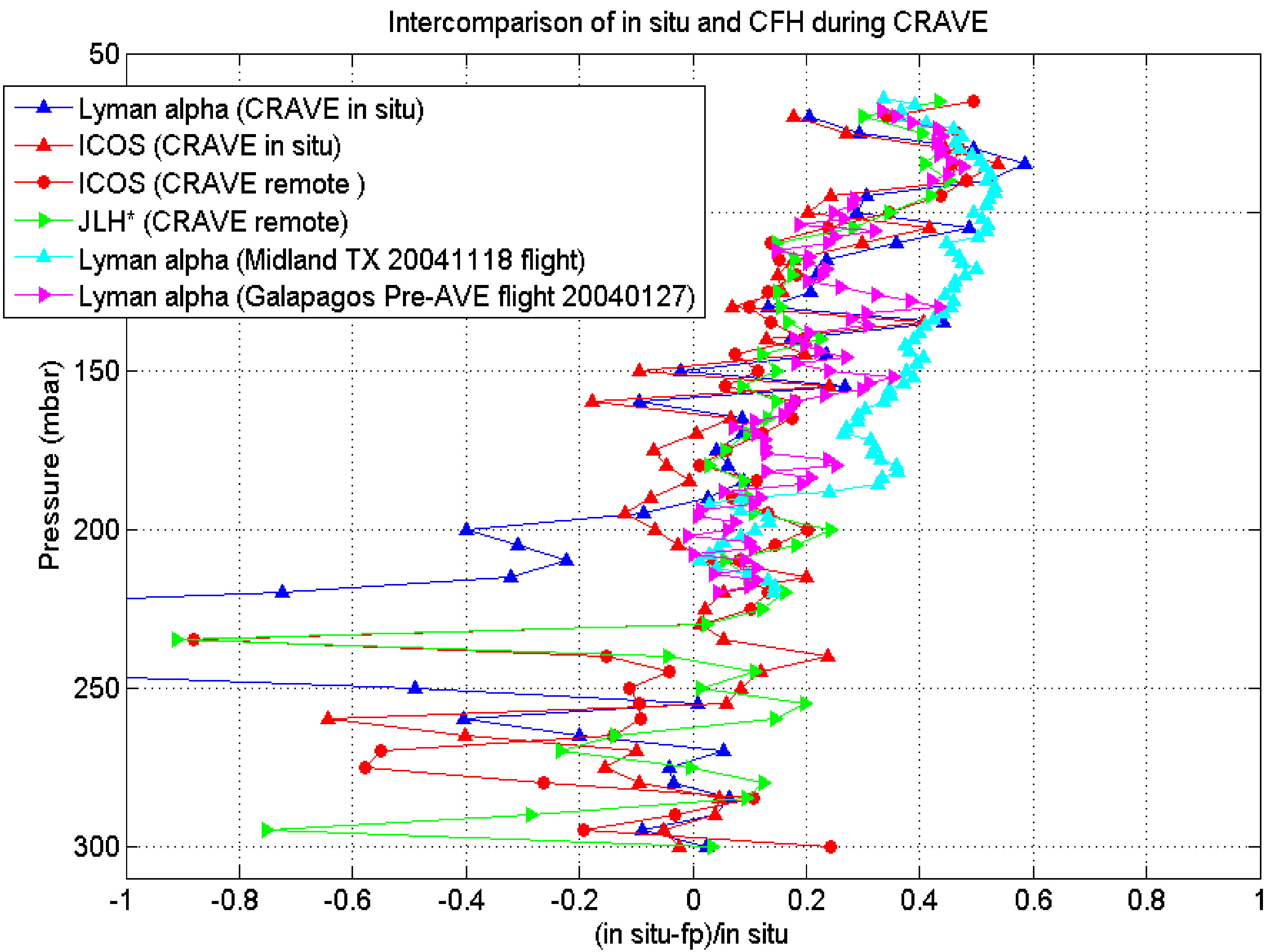
Elliot Weinstock



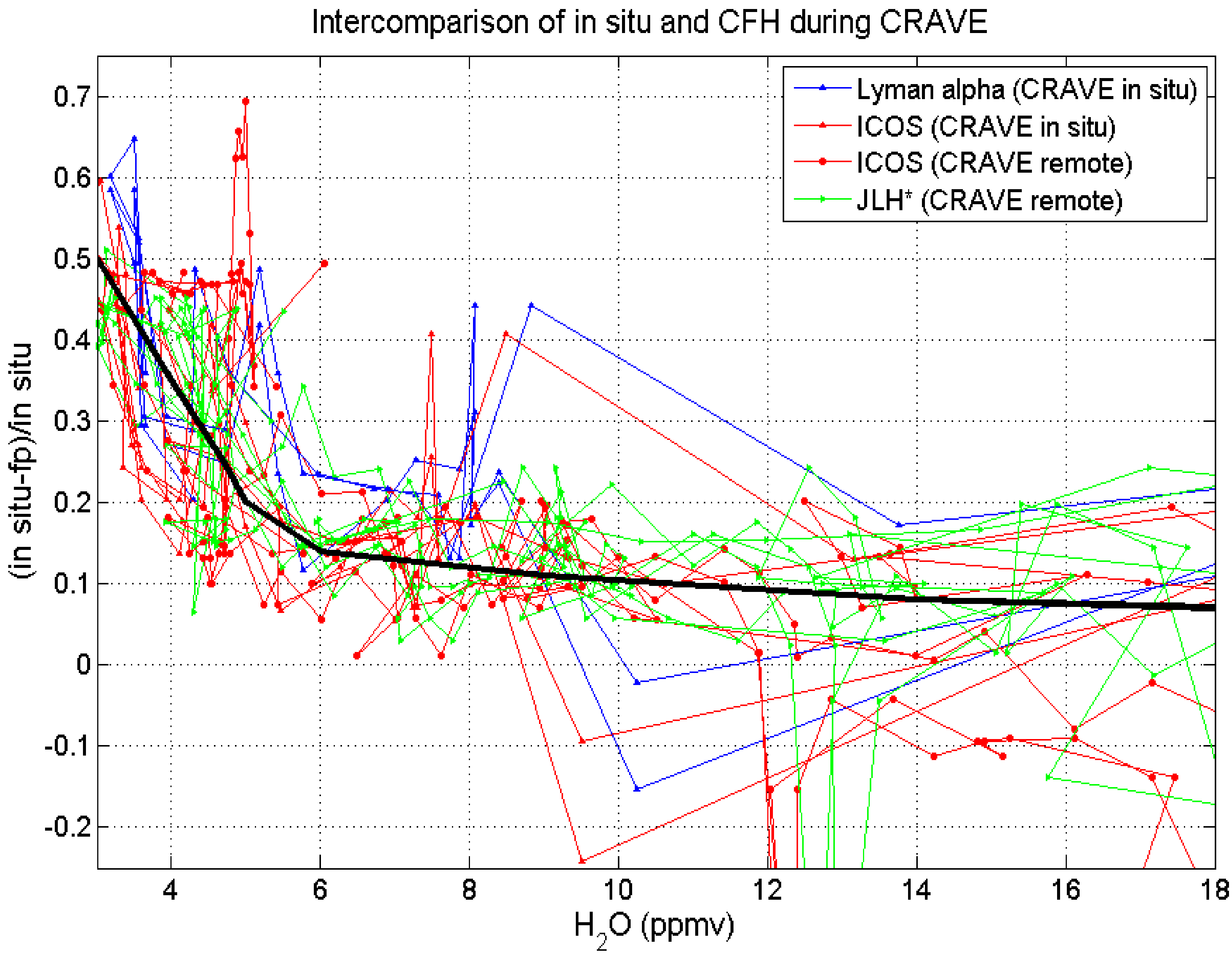
Elliot Weinstock



Elliot Weinstock



Elliot Weinstock



Elliot Weinstock

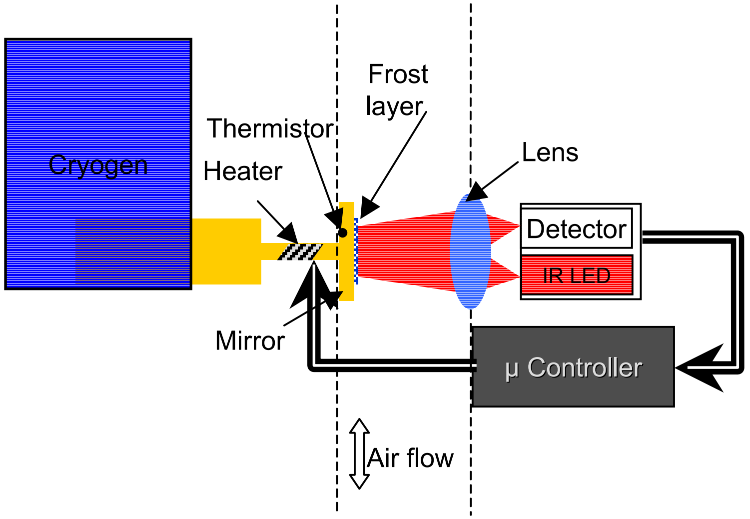
Conclusions

- As in AVE-WIIF, the overall agreement between Harvard water vapor instruments during CRAVE was very good.
- Comparisons between in situ water vapor on the WB57 and the CFH instrument illustrate systematic differences that increase significantly at low water vapor.
- Missions that provide the opportunity for careful water intercomparisons continue to be very useful and need to continue.
- Laboratory intercomparisons with low water vapor mixing ratios need to be carried out to help determine the source of this discrepancy.

Elliot Weinstock

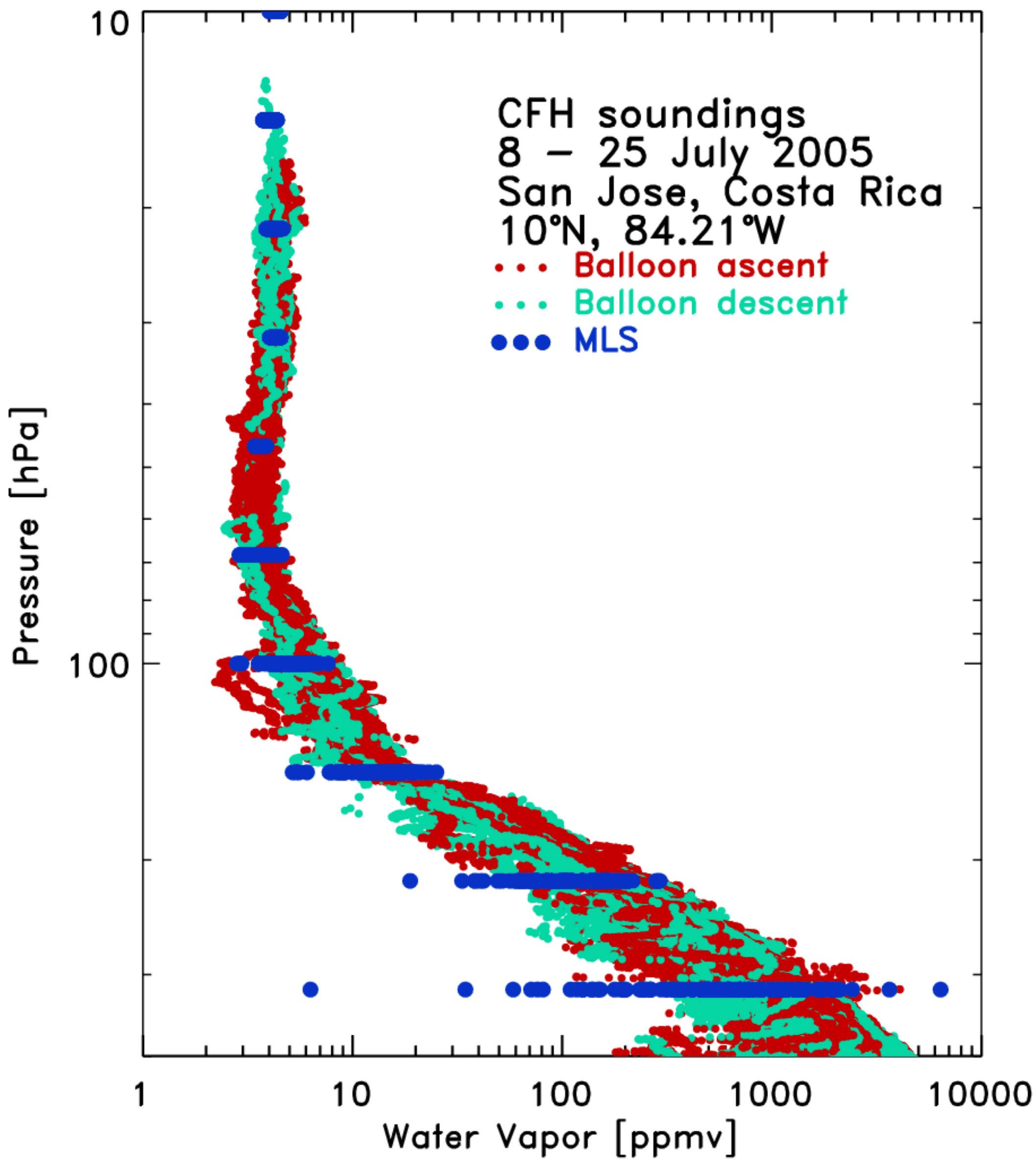
Cryogenic Frostpoint Hygrometer (CFH)

- Absolute measurement
- Vertical Range: surface to ~28 km
  (surface to ~25 km on ascent)
- Uncertainty: troposphere: > 4% MR
  stratosphere: ~ 9 %
- Microprocessor control
- Phase sensitive detector:
  electronic sunlight filter
- Weight: ~ 400 gr
- Payloads carry ECC ozone sonde and Vaisala RS80
- ~170 soundings so far



Holger Vömel

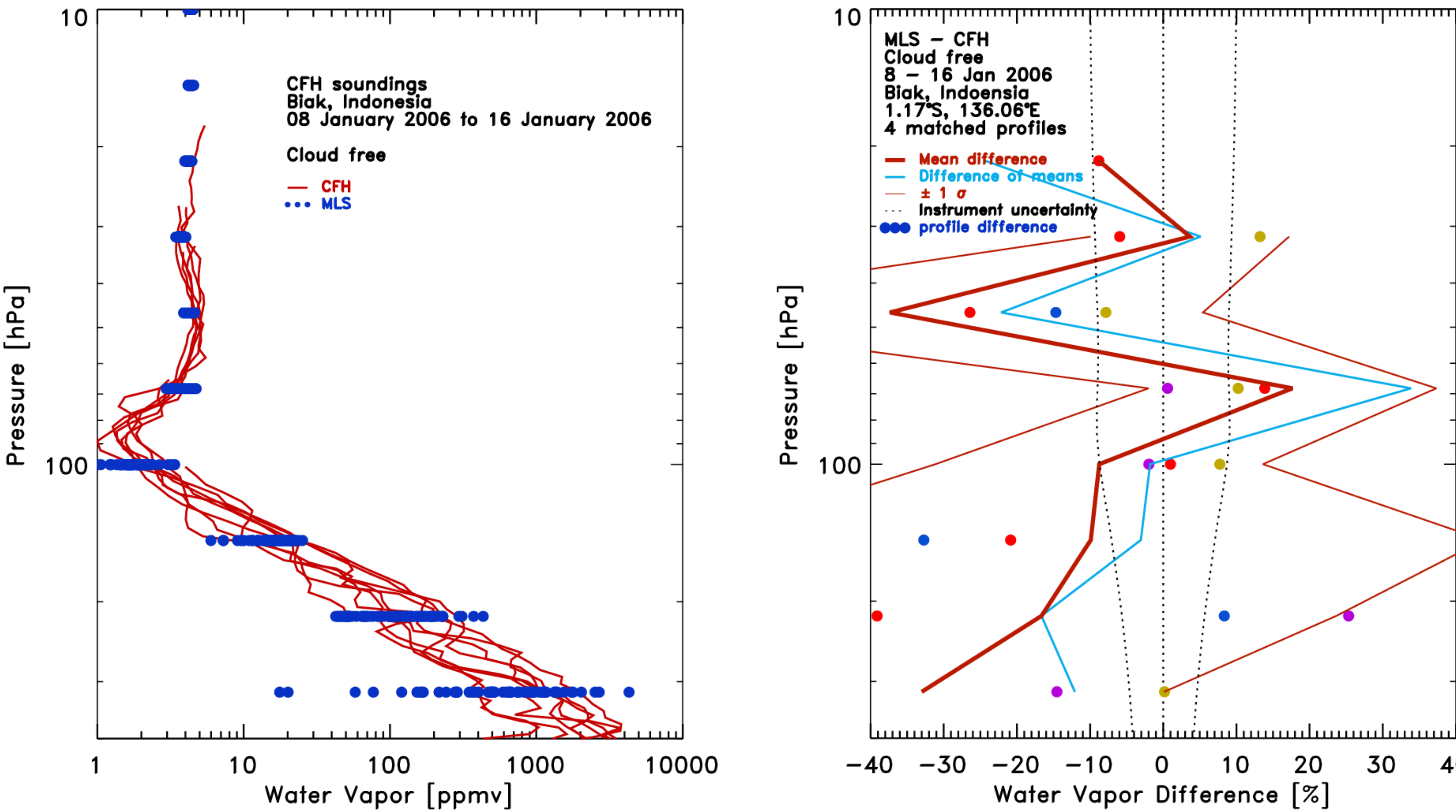
Satellite comparison



Holger Vömel

MLS Comparison: Tropics

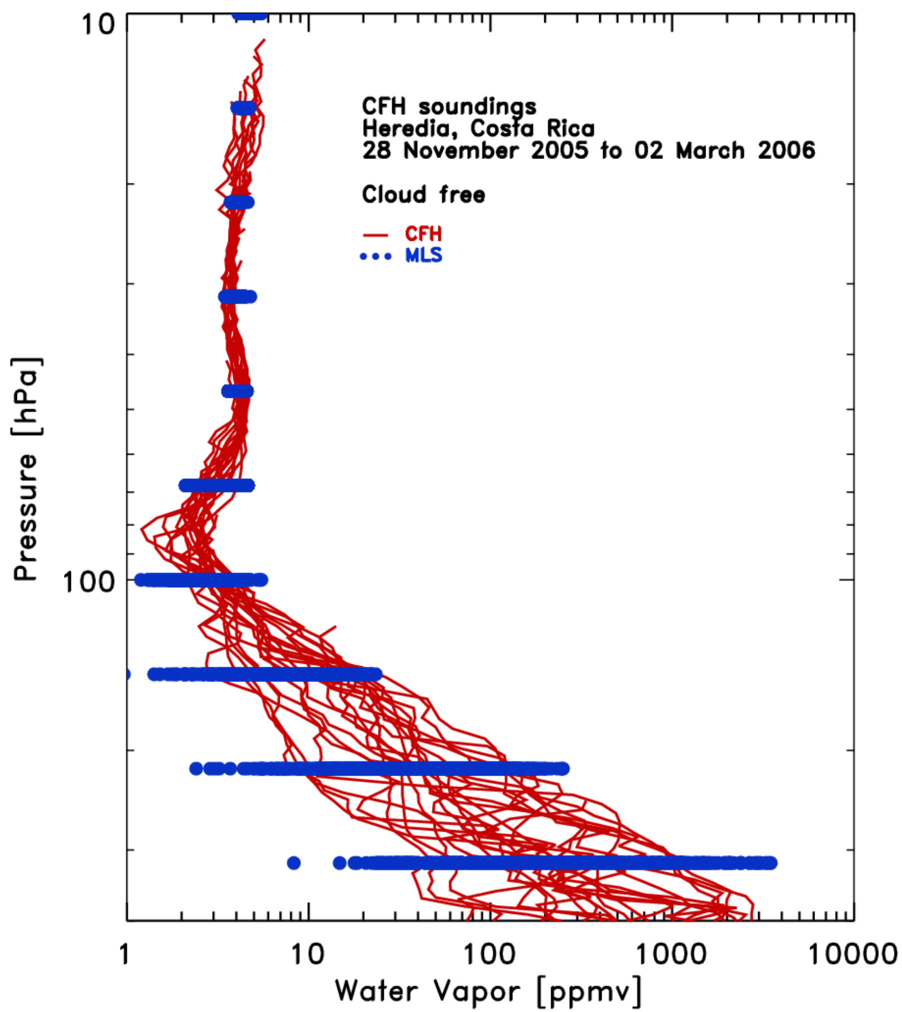
Biak Indonesia: Jan 2006

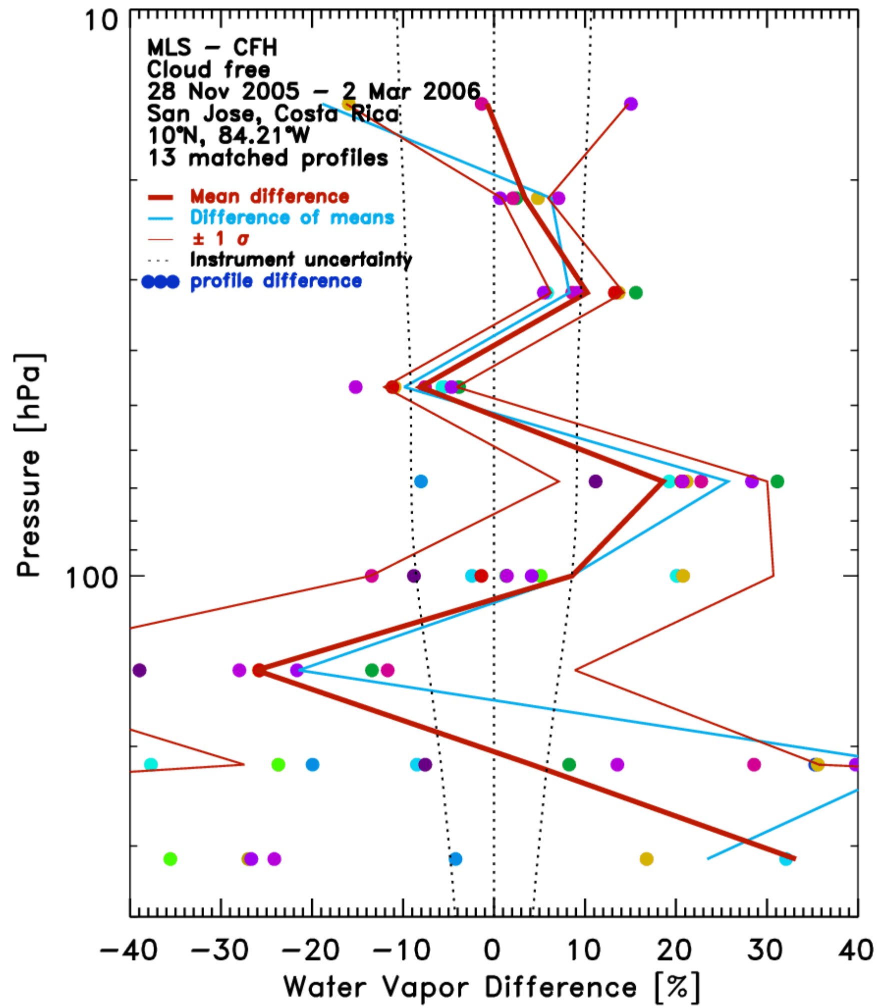


Holger Vömel

MLS Comparison: Tropics

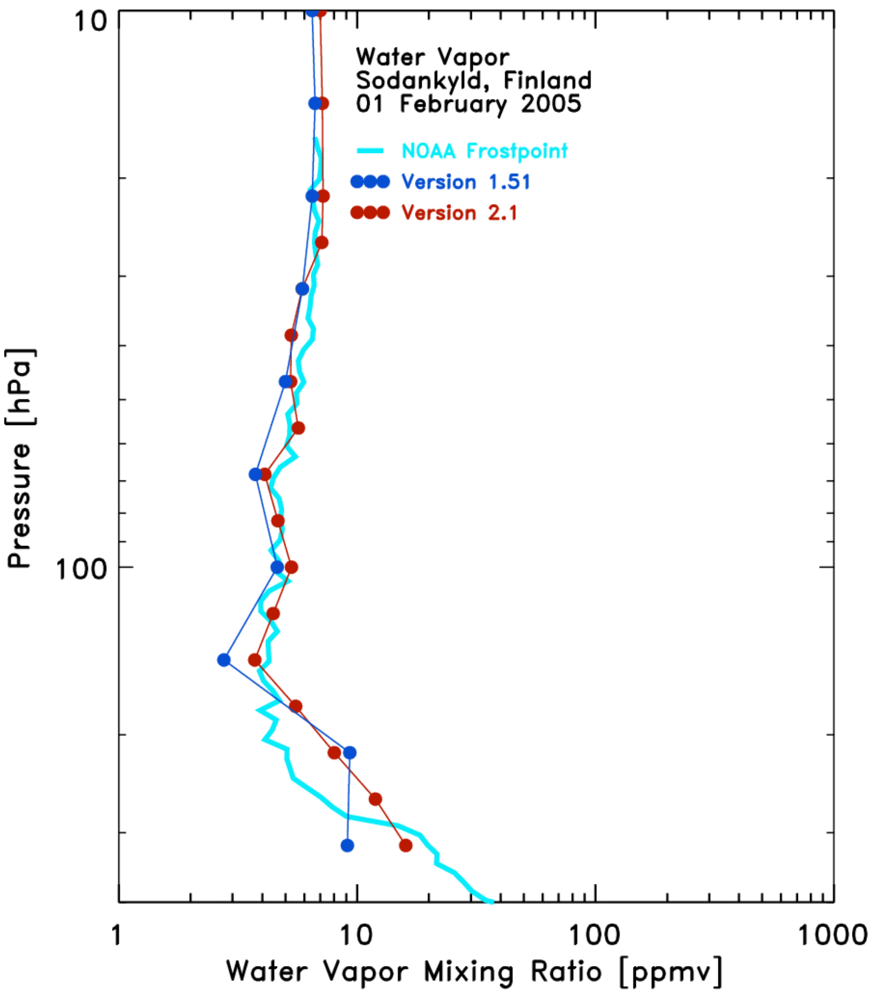
Costa Rica AVE Jan/Feb 2006

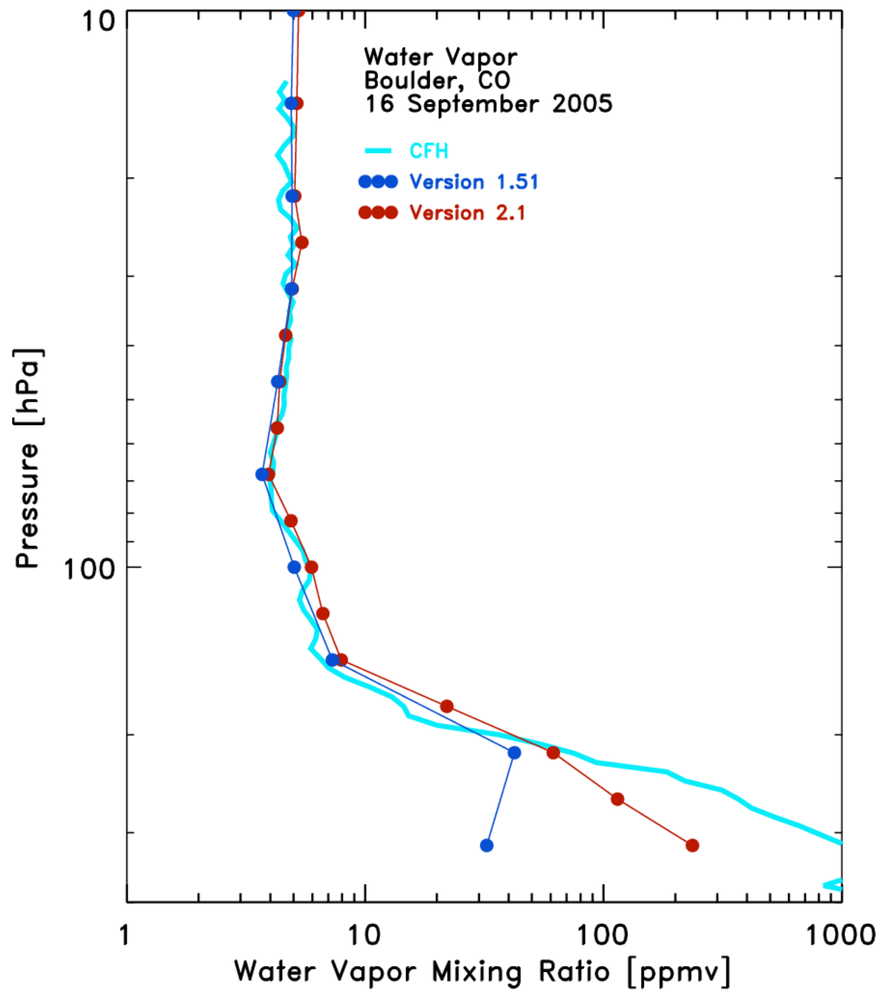




Holger Vömel

Sondakylä & Boulder example

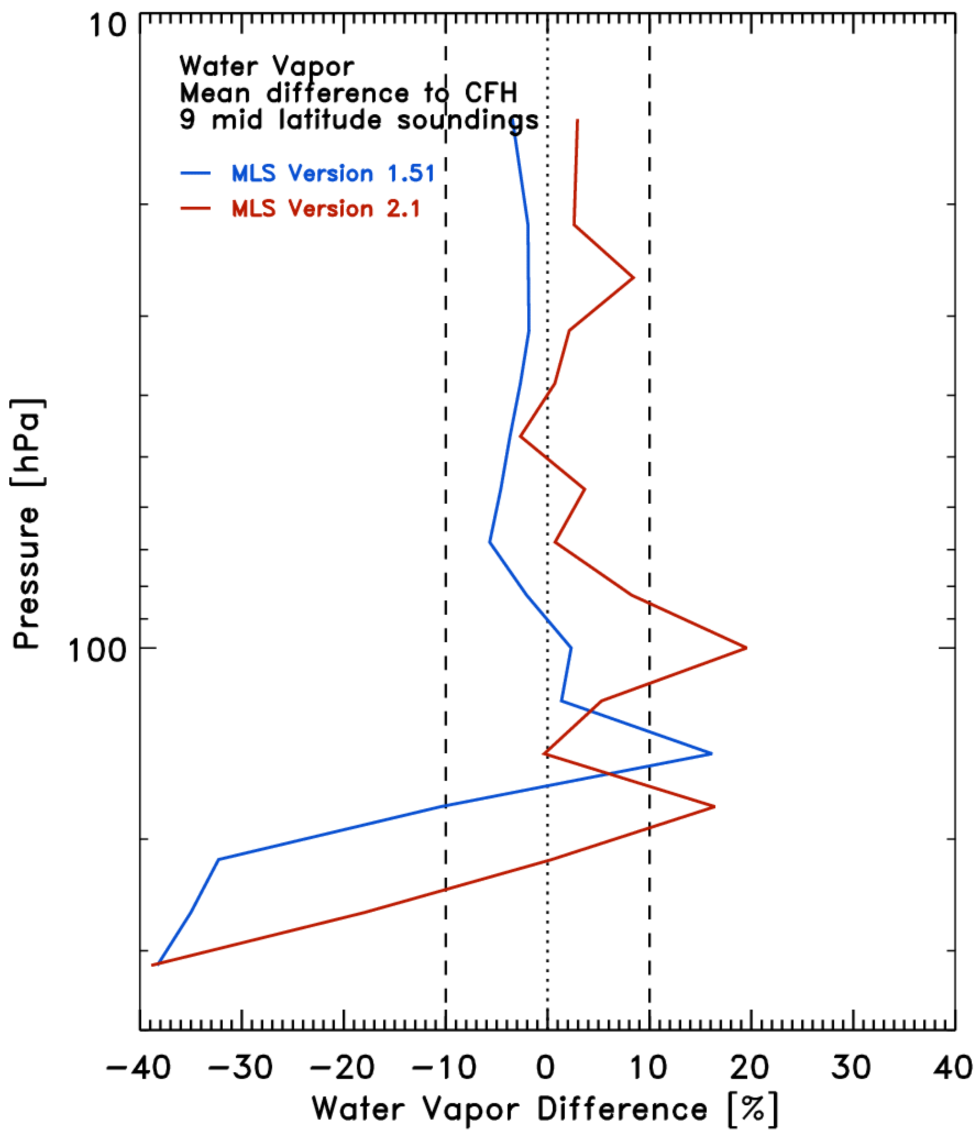




1.51 and 2.1 and CFH

Holger Vömel

Average difference from CFH: version 1.5 & 2.1



Mid and high latitudes only

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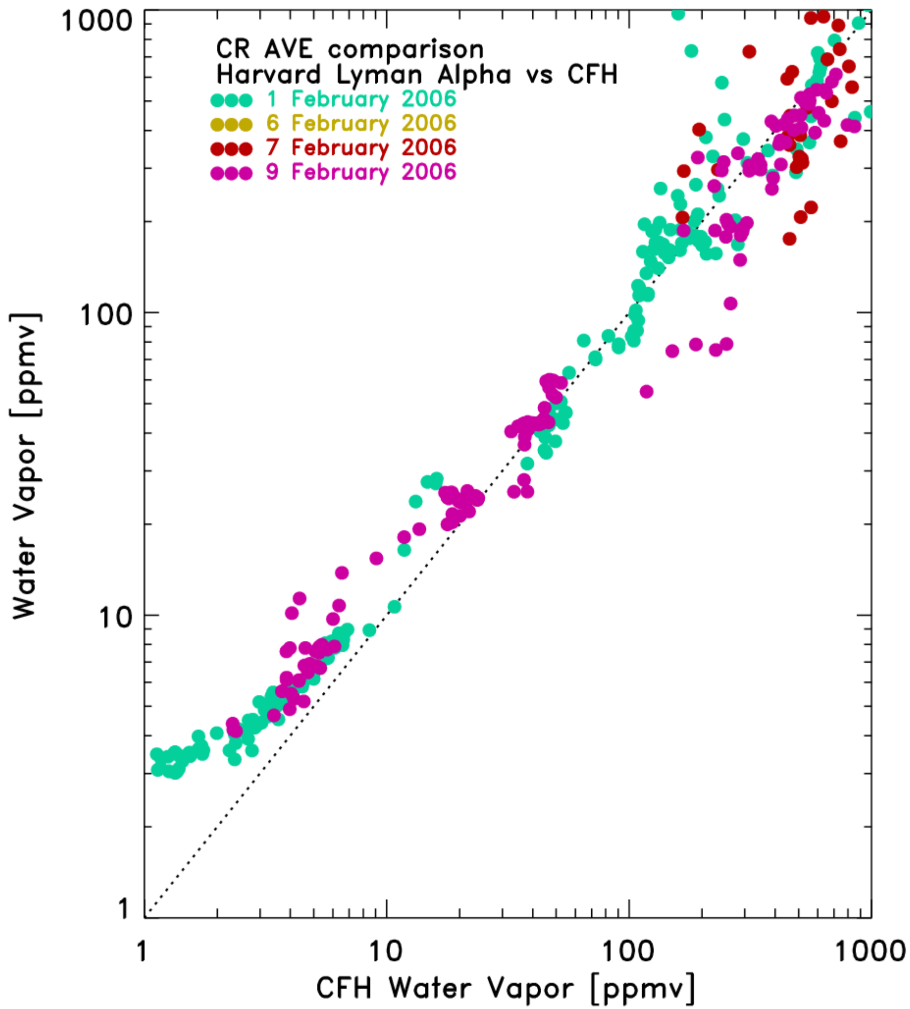
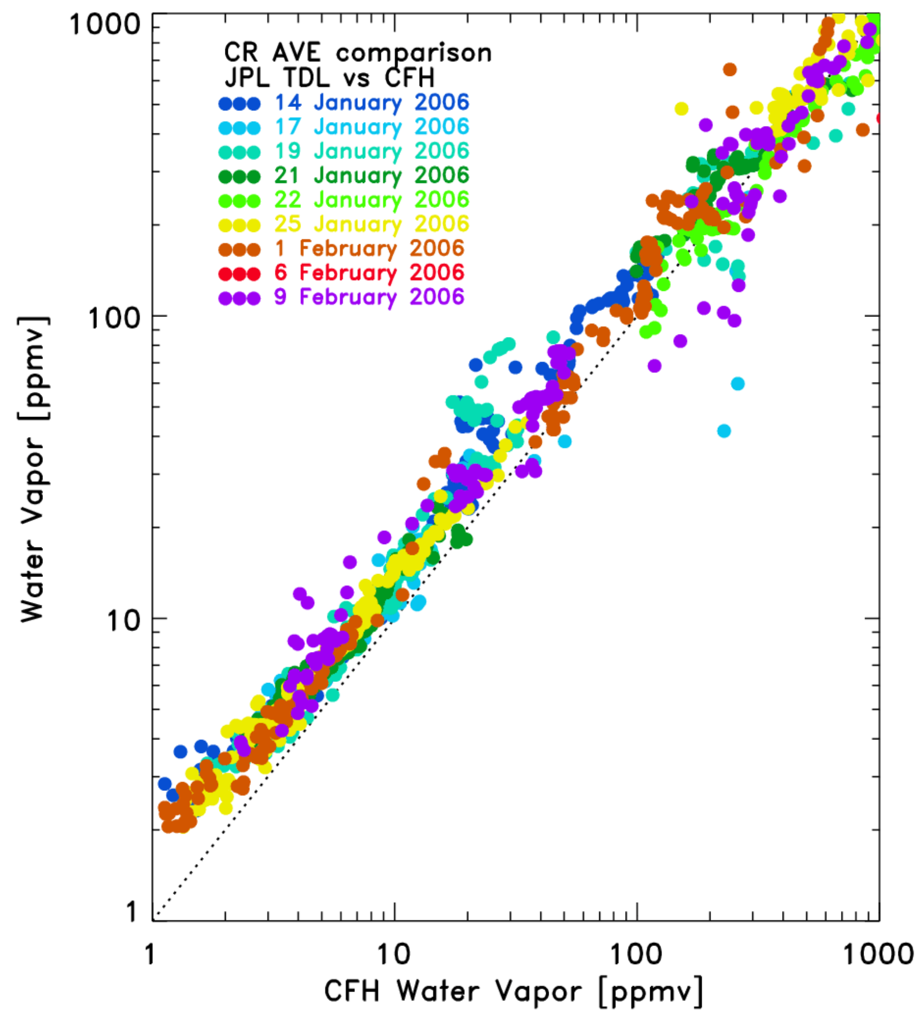
CFH Correlations





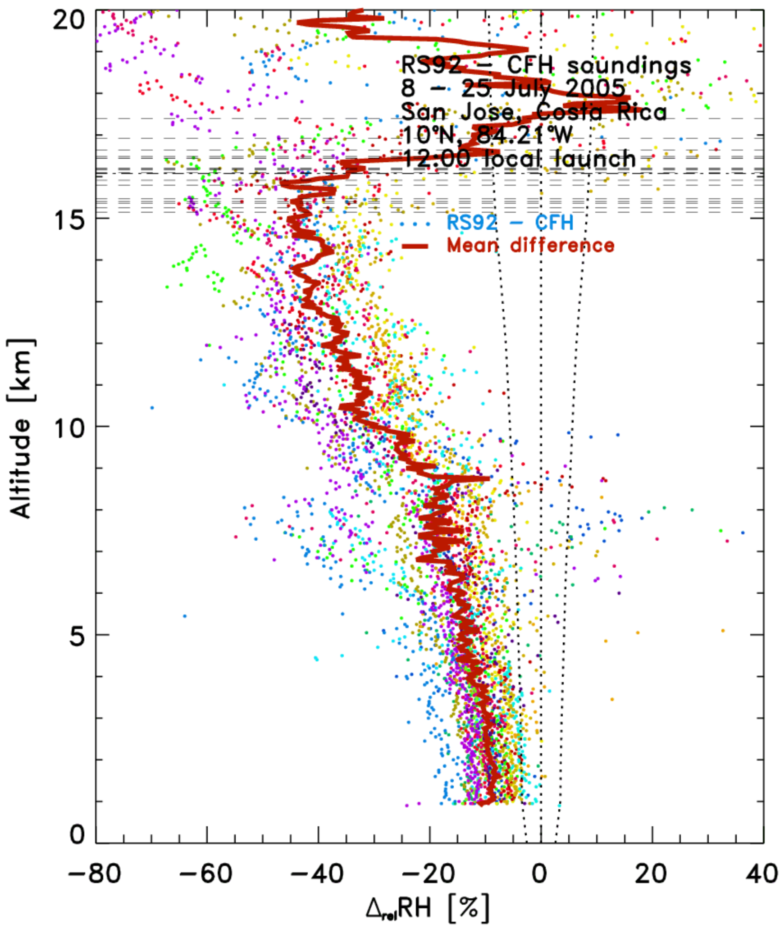
Harvard Ly-alpha

JPL TDL

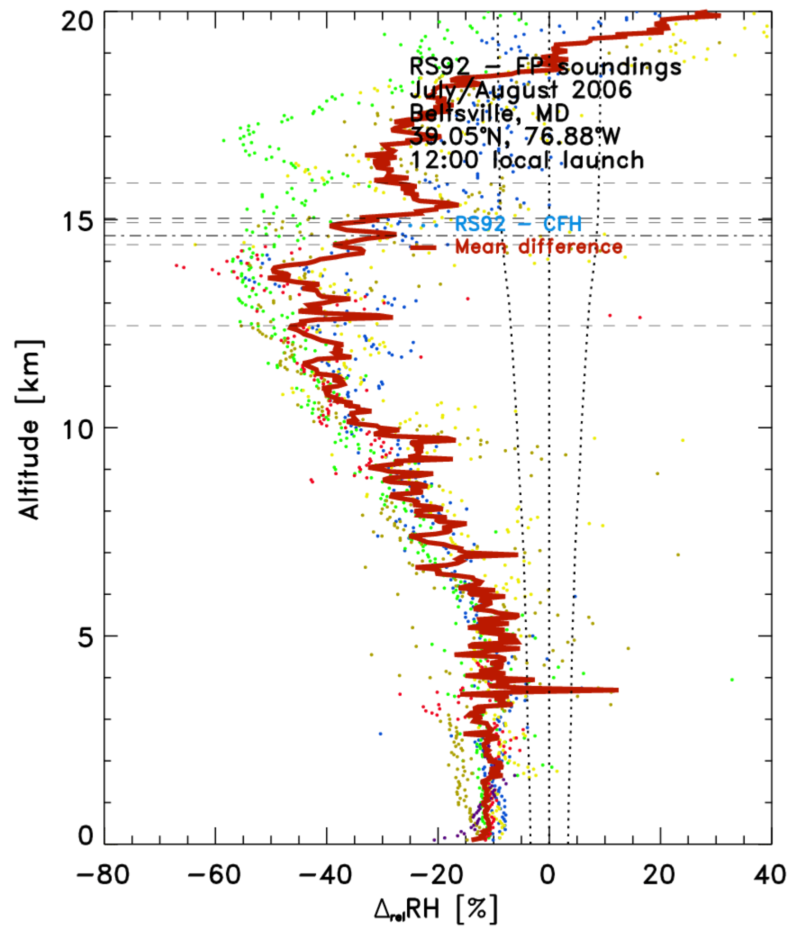
Constant offset, ly-alpha, scaling factor with JLH

Holger Vömel

Relative RH difference RS92 - CFH



Costa Rica Jul 2005



Beltsville, MD Jul 2006

Shows daytime dry bias of RS92 in UT

Holger Vömel

Summary

- Stratospheric MLS water vapor:
  Agreement within measurement uncertainty for both version 1.5 and 2.1
- Except for tropical tape recorder during boreal winter

- Tropospheric MLS water vapor:
  Version 2.1 improves general shape in UT,
  but still very dry and highly variable

- WB57 instruments are too wet compared to CFH;
  no serious disagreements between CFH and other balloon or Geophysica instruments

- Vaisala RS92 relative humidity during daytime still up to 50% too dry (same as last year)

Holger Vömel

What are the major validation issues that remain?
How does reprocessing affect validation plans?
What additional correlative measurements are needed?
What additional analyses are needed?
What papers are planned/completed at this point?

One big issue...sorting out why different *in situ* differences at low mixing ratios.

In regards to validation papers, the question came up as to whether there will be enough reprocessing done (for MLS).

Prioritizing reprocessing to match where correlative measurements exist is needed.

TES likely needs more accurate UT measurements (considering problem with daytime operational sonde measurements in the UT.

Need to consider continuation of trends in the stratosphere, so matching up existing Aura measurements with past satellite measurements is important (see poster by Brad Sandor).